Project Danube Hazard m3c:
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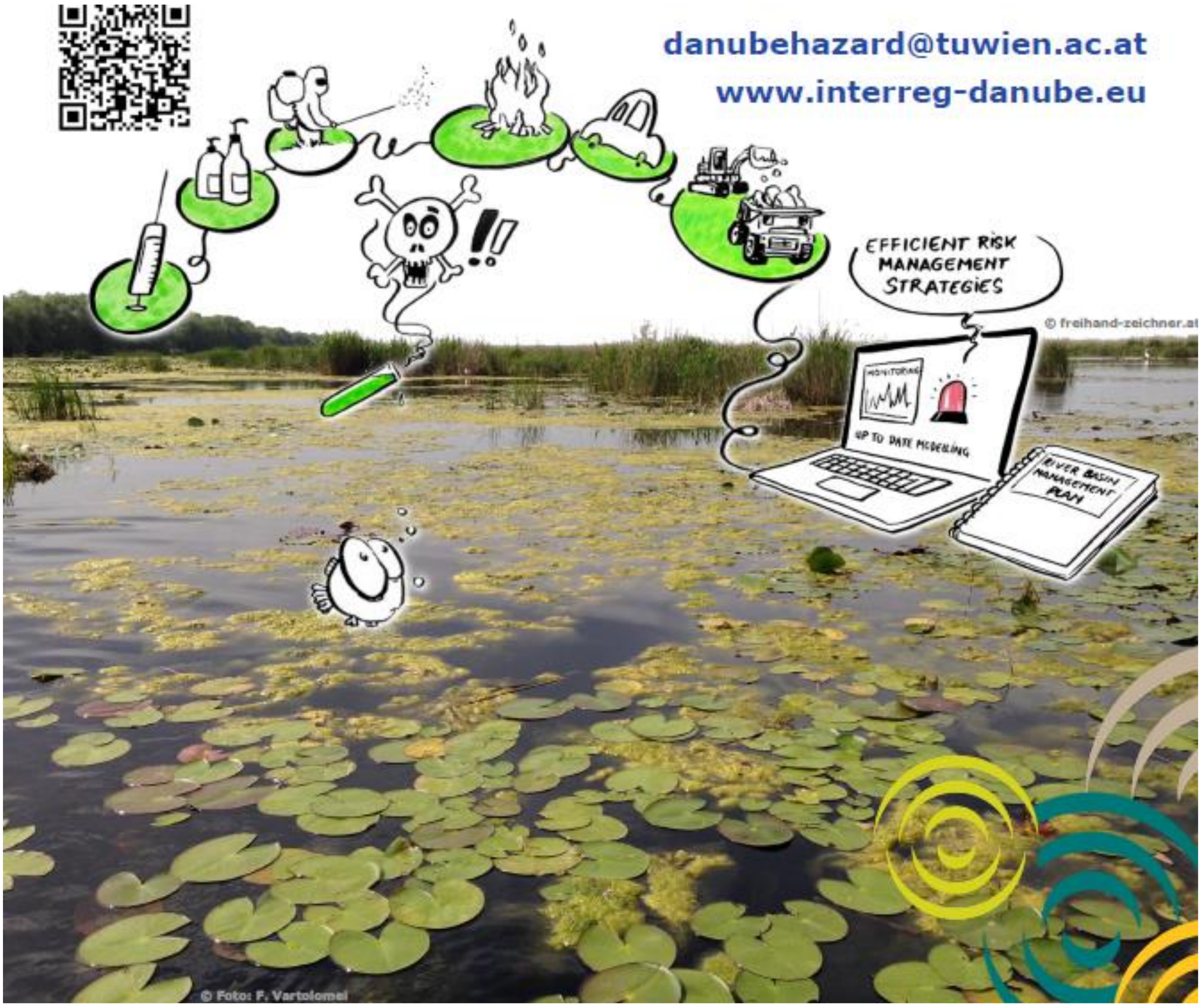
Demonstration of the management plan development – factsheet Ybbs



Output T2.3

Demonstration of the management plan development process at watershed levels for Hazardous Substances pollution based on detailed emission modelling in seven pilot regions 2023

Factsheet for the Ybbs Pilot area

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PROJECT TITLE: Tackling hazardous substances pollution in the Danube River Basin by Measuring, Modelling-based Management and Capacity building

ACRONYM: Danube Hazard m^{3}c

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1. Introduction

Amongst other tasks, Danube Hazard m^{3}c was carried out to fill knowledge gaps in the management of hazardous substances in the Danube Region and to demonstrate modeling as a support system for the EU-WFD Management Cycle. In seven pilot regions in Romania, Bulgaria, Hungary and Austria, detailed monitoring strategies were established to close data gaps in several technical and environmental compartments. Emission modelling, using the MoRE Model was established, based on intensive data acquisition, which was carried out by the responsible project partners of pilot regions and supported by the Environment Agency Austria.

After validation of the model for several chemicals from different substance groups (e.g. industrial chemicals: PFOS, PFOA; heavy metals: Cd, Cu, Cr, (…); pharmaceuticals (Diclofenac, Carbamazepine) and for the first time pesticides (Metolachlor, Tebuconazole), results were used to demonstrate:

- The use of Emission modelling to support the risk analyses
- The use of Emission modelling to characterize regional sources and pathways (system analyses)
- The use of Emission modelling as support system for establishing a Program of Measures
- The use of Emission modelling to quantify the effectiveness of mitigation measures by scenario-analyses.

The pilot regions were selected in advance to reflect various stress situations and focal points, such as rather undisturbed regions like Ybbs or Vit, regions significantly influenced by a large Waste Water Treatment Plant (WWTP) like Somesul Mic, regions with increased anthropogenic activities (Wulka, Zagyva), a region with significant agricultural use (Koppany) and a region, influenced by abandoned mining (Viseu). Each pilot region shows characteristic patterns of stresses from Hazardous Substances. The identification of these stresses and the way to manage them, supported by model results should be briefly summarized in factsheets, demonstrating the use of Emission modelling in the Management Cycle.

Based on a one-year surface water monitoring, samples were taken once a week and combined to two-months composite samples and analyzed. Sampling took place mostly at low and mean flow conditions. The monitoring was established in seven pilot regions in four countries (RO, BG, HU, AT) with a total of 20 surface water monitoring sites. From these results a mean annual concentration was calculated, which should be comparable to 12 fold monthly monitoring results, often used for the risk assessment under the Water Framework Directive. Monitoring results were supported by modelling results.

The risk assessment considers the following different inorganic and organic substances:

- Perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA) (industrial chemicals),
- 16 EPA Polycyclic aromatic hydrocarbons (PAHs, industrial chemicals, and combustion by-products),

- Mercury (Hg), Cadmium (Cd), Copper (Cu), Nickel (Ni), Lead (Pb), Zinc (Zn), Chromium (Cr) and Arsenic (As) (Heavy metals) ,
- Diclofenac and Carbamazepine (pharmaceuticals),
- 4-tert-Octylphenol (industrial chemical),
- Nonylphenol (industrial chemical),
- Bisphenol A (industrial chemical),
- S-Metolachlor (herbicide) including Metolachlor-ESA and Metolachlor-OA (metabolites),
- Tebuconazole (fungicide).

Results from all monitoring stations and model results were compared with the environmental quality standards (EQS) of Directive2008/105/EU (Priority Substances) and with the substances enacted at the national level (National Substance List). Exceedances are shown in Table 1.

Table 1: Overview of the exceedance of the EQS in all pilot areas. The numbers indicate the number of sites, regions and countries with exceedance of the EQS values.

Substance > EQS	Substance Group	No of monitoring sites	No of pilot regions	No of countries	Regulation
PFOS	Industry	9	5	4	Directive 2008/105/EU
Cu	Heavy Metals	2	1	1	National Substance List
Cd	Heavy Metals	2	1	1	Directive 2008/105/EU
Zn	Heavy Metals	2	1	1	National Substance List
s-Metolachlor	Pesticides	2	1	1	National Substance List

In a second step, for each substance the dominant pathways were evaluated for each catchment by means of emission modelling. Considering the dominant polluters or emission pathways, scenarios were formulated, which describe the general potential of a specific measure to mitigate pollution.

The emission modelling was carried out for 34 sub catchments in seven pilot areas. A detailed description of the model, the modelling results and validation can be found in OT 2.2 Report on improved system understanding. A SQLite model version with all seven pilot regions implemented and a technical description of the model setup can be found in OT 2.1 Harmonized MoRE Model (https://www.interreg-danube.eu/approved-projects/danube-hazard-m3c/outputs).

Note: The new proposals of the revised Priority Substance List were also assessed, but do not form a legal basis for the designation of measures at the present time.

2. General information Ybbs pilot region

The Ybbs pilot region on the northern edge of the Alps is divided into eight sub catchments and ends at the outlet of sub catchment 11001. Here a monitoring station is established as well as in the tributary Url (11002) and in the upper reaches of the Ybbs in Opponitz (11005). Monitoring stations were associated with existing gauging stations. Conceptual, this allows gaining concrete information from the measurable part of the catchment (11001), from a tributary with increased agricultural use (11002) and from the largely unaffected regions in the upper reaches.

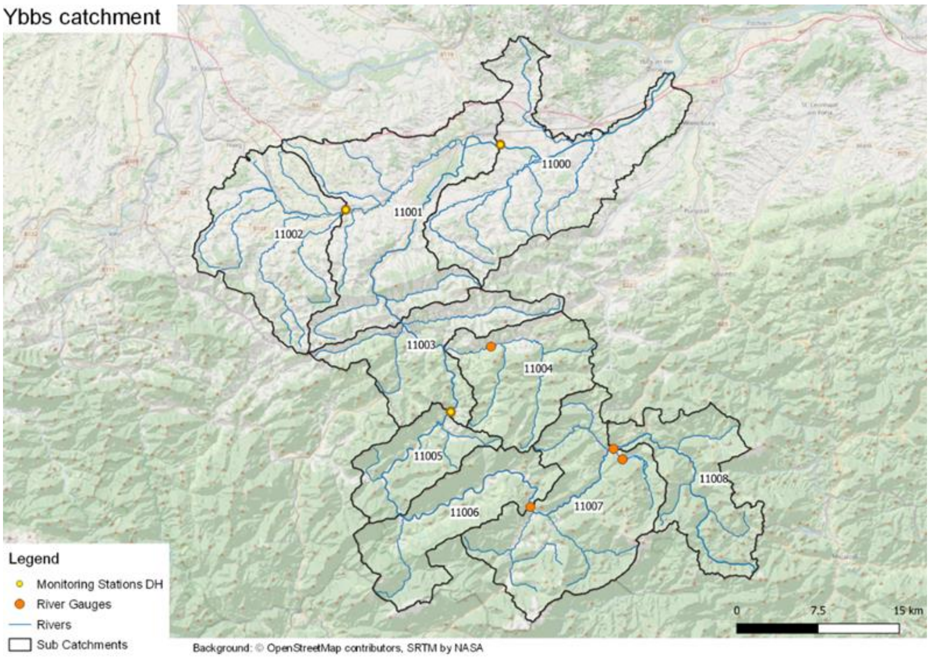

Figure 1: Overview of the pilot area, with monitoring stations.

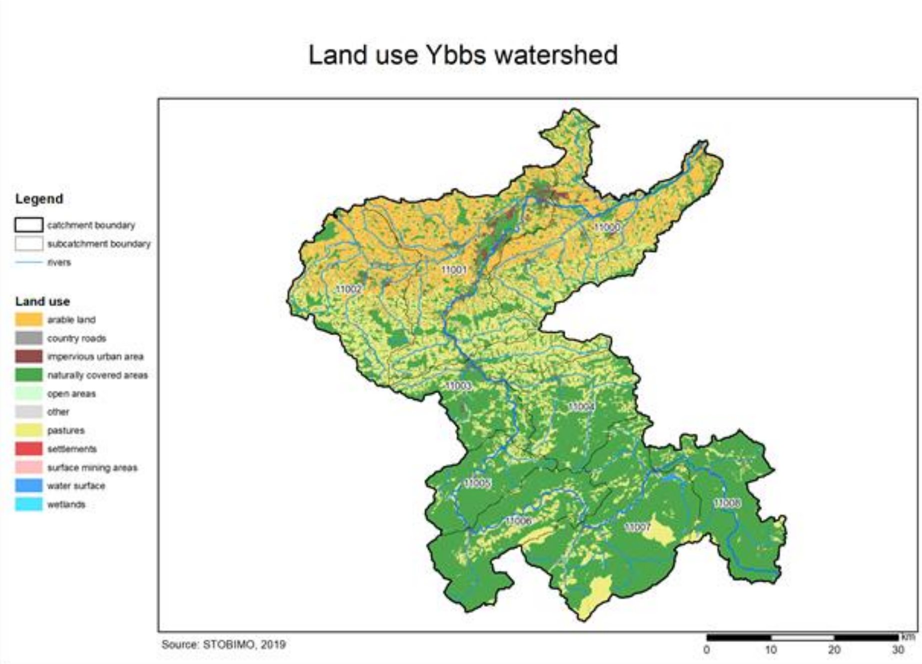

Figure 1: Land use in the pilot region.

The pilot region shows a clear upstream downstream gradient, with wide natural areas (forests) in the upper pre-alpine reaches and increasing anthropogenic use in the direction of the outlet (Figure 2). In total Ybbs is a moderately populated pilot region (compared to the other pilot regions) with extended forests, pastures and a growing share of agricultural land in the downstream sub catchments (especially in the Url sub catchment, 11002) but also in the outlet catchment 11001.

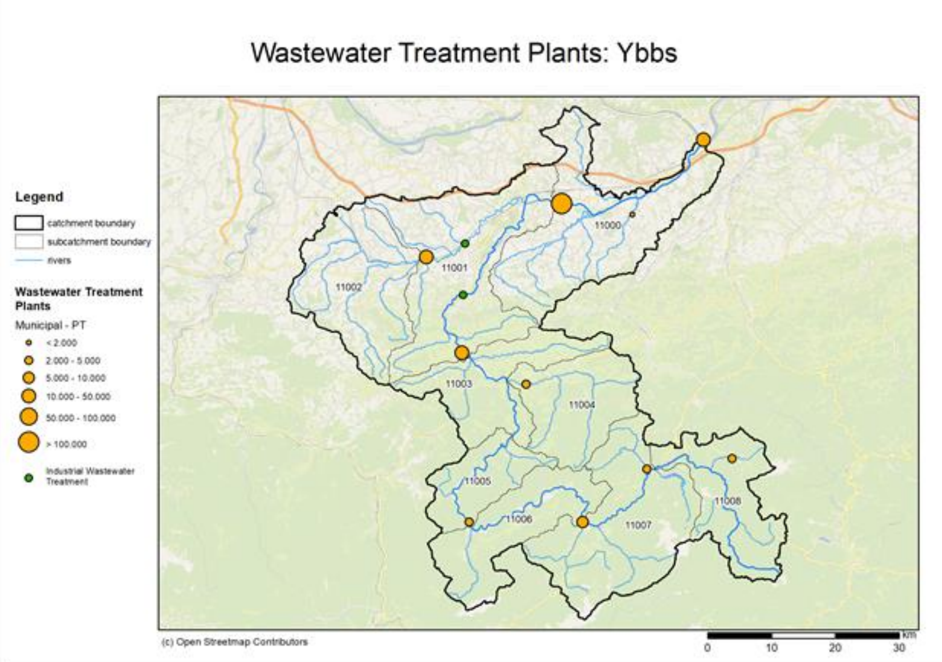

Figure 2: Overview of the point sources in the pilot region.

In the Ybbs pilot region seven municipal WWTPs with a capacity above 2000 PE and two industrial WWTPs are situated (Figure 3). Please be aware that sub catchment 11000 is not included in both the monitoring and the modelling. Consequently, the two largest municipal WWTPs under investigation are located in 11001 "Waidhofen an der Ybbs", with a capacity of 31,000 PE and "Oberes Urltal", with a capacity of 18,000 PE.

The share of urban area is low and the population density low to medium, compared to the other pilot regions under investigation but become more relevant in the downstream sub catchments (Table 2). The average runoff in the Ybbs pilot region is high.

Table 2: Basic information for the Ybbs pilot region.

Pilot region	Catchment Area [km2]	Mean Elevation [m]	Population density [Inh/km2]	Arable land [%]	Arable land > 4% slope [%]	Pasture [%]	Forest [%]	Urban Area [%]	Runoff [mm]
Ybbs	1111.9	685.8	68	11.8	8.2	24.9	58.7	0.4	811

In Figure 4, the water balance of the pilot region is presented. Runoff is clearly dominated by subsurface components like base flow and intermediate flow with around 75%. Also surface runoff is relevant with 23% with higher shares in the upper pilot region and decresing shares in the lower regions.

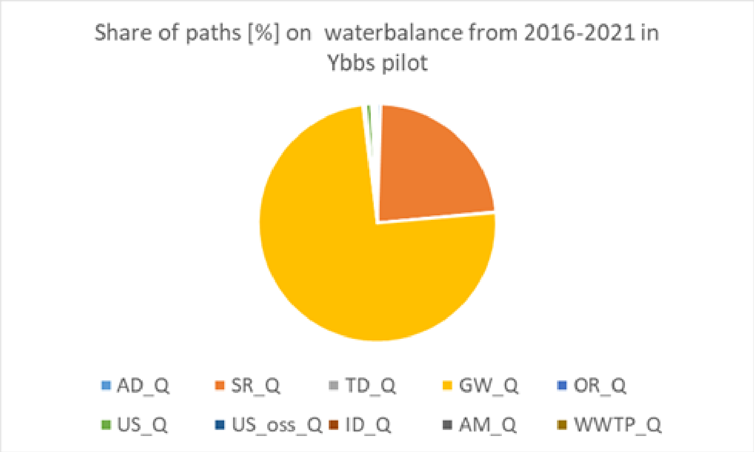

Figure 4: Share of different water balance components on the total runoff in the pilot region Ybbs. (AD_Q: atmos-pheric deposition; SR_Q: surface runoff; TD_Q: Drainages; GW_Q: subsurface flow (base flow interflow); OR_Q: extra-urban roads; US_Q: combined storm water overflow and storm system; US_oss_Q: ID_Q: industrial WWTPs; sewer systems without connection to WWTP; AM_Q: abandoned mining; WWTP_Q: municipal WWTPs).

3. Risk assessment: Industry and wastewater/Perfluorooctane sulfonic acid (PFOS)

In the Ybbs pilot region the PFOS EQS (0.00065 µg/l) is exceeded at monitoring site 11001 by factor 1.1. The monitoring and the model results for all other sub catchments give evidence that PFOS concentrations will be significant below the EQS.

General information: Perfluorooctane sulfonic acid (PFOS) (CAS number 1763-23-1) belongs to the substance group of per- and polyfluorinated alkyl compounds. Due to the surface-active properties of PFOS and related compounds, they are also referred to as perfluorinated surfactants (PFTs). PFOS were formerly used in a wide variety of applications such as fire extinguishing foams, photo resist paints, photographic coatings, medical devices, insecticides, textiles and carpets, and paper and packaging. Due to persistence and surface-active properties, once contaminants such as PFOS enter wastewater, they are very difficult to remove. The main pathways of PFOS to enter in surface waters are wastewater effluents (industrial and municipal wastewater), surface runoff and groundwater.

3.1 A regionalized analyses of pathways in Ybbs pilot region

The modelled area-specific loads in the Ybbs pilot region show a rather homogeneous pattern in the different sub catchments with elevated values. The increased values stem from high runoff conditions, especially in the upstream area. In the mid and downstream area the area-specific load slightly decreases, while in the outlet sub catchment 11001 the trend is reversed, as here the emission from the wastewater treatment plants show their influence (Figure 5).

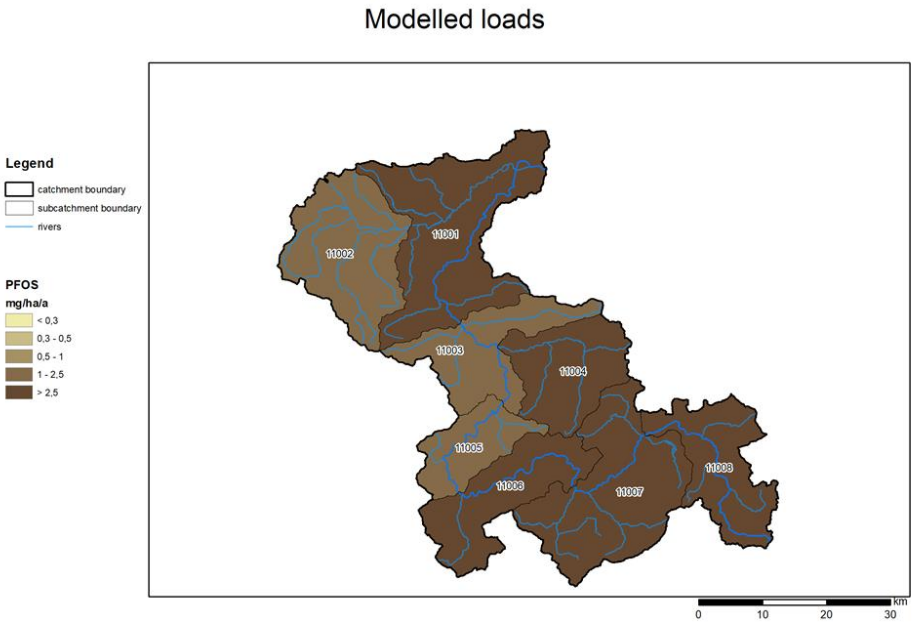

Figure 5: Area specific total PFOS emissions in the Ybbs catchment.

The dominant share of the PFOS emission in the upstream sub catchments stem from groundwater and surface runoff (Figure 6), which do lead to surface water concentrations significantly below the EQS (results from monitoring and modelling results).

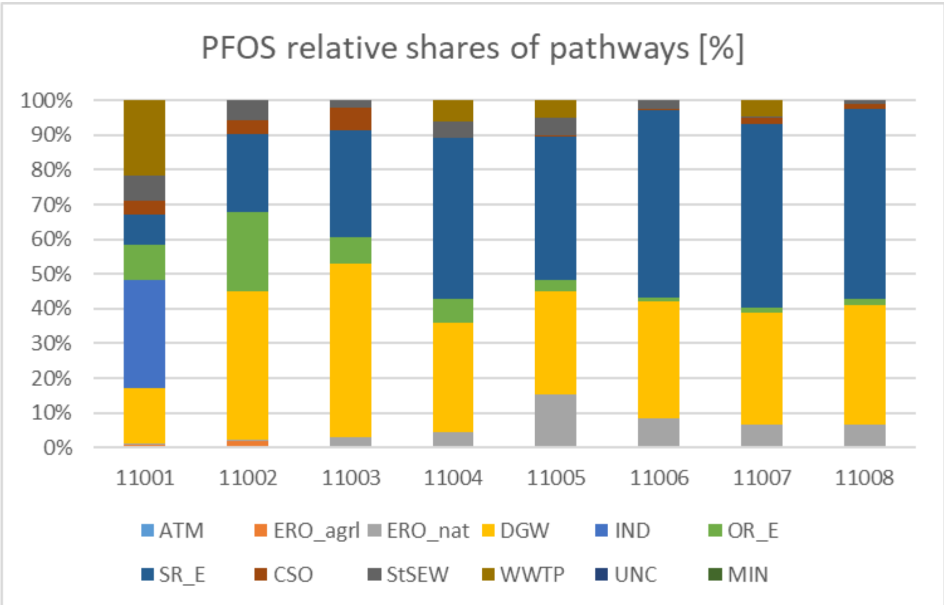

Figure 6: Relative share of pathways for PFOS in all Ybbs sub catchments. (ATM: atmospheric deposition; ERO_agrl: erosion from agricultural land; ERO_nat: erosion from forests; DGW: groundwater baseflow+inter-flow+drainages; IND: industrial point sources; OR_E: extra-urban roads; SR_E: surface runoff; CSO: combined stormwater overflow; StSEW: strom sewer; WWTP: municipal WWTP; UNC: sewer systems not connected to WWTP; MIN: abandoned mining).

The increase of PFOS concentration in catchment 11001, which leads to an exceedance of the EQS by factor 1,1 is mainly related to the influence from WWTPs (>10,000 PE) with a share of 21% on total PFOS emissions and from industrial direct dischargers (25%), but also from rainwater discharges via separate sewer systems (8%) in this more urban area.

3.2 Proposals for potential mitigation measures

Advanced wastewater treatment at treatment plants in sub catchment 11001 >10,000 PE is one proposed measure, which seems technically feasible and suitable to correct the minor exceedance of PFOS EQS. In catchments with risk the fourth treatment stage is proposed to be implemented by 2040 on municipal WWTPs >10,000 – 100,000 PE.

Information from the Swedish EPA (2017) point out, that the purification capacity of PFOS can be increased to 75% by using activated carbon.

The second proposed measure is to tighten regulations on industrial emissions, and introduction of emission limit values. PFOS emissions can also be linked to industrial activity (primary sources are metal processing and metallurgy, but the processing industry is also a potential source). Based on the relevant legislation, effluent control only covers the substances specified in the operating license. Existing permits should be revised with the expansion of the range of parameters included in self-monitoring. Stricter self-monitoring of direct industrial emitters and industrial plants discharging the public sewer would be required.

In the scenario

3.3 Presentation of the effectiveness of measures through scenario analyses

In the emission model the measure "Advanced wastewater treatment at the municipal wastewater treatment plants (>10,000 PE)" was implemented.

If the PFOS concentration of municipal WWTPs with a capacity above 10,000 is reduced by 75%, due to the implementation of advanced treatment with activated carbon, the river concentration of PFOS will reduce by 6% in sub catchment 11001. Consequently the factor of exceedance would decrease from 1.1 to 1.0.

4. Literature

Swedish EPA (2017). Advanced wastewater treatment for separation and removal of pharmaceutical residues and other hazardous substances: Needs, technologies and impacts. Swedish Environmental Protection Agency. Report 6803, April 2017, Stockholm, Schweden. https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6803-5.pdf?pid=21820

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